

of calculations. In other embodiments, determining the haptic effect may comprise accessing a lookup table. In still other embodiments, determining the haptic effect may comprise a combination of lookup tables and algorithms.

**[0044]** In some embodiments, determining the haptic effect may comprise a haptic map. In such an embodiment, determining the haptic effect may comprise mapping the display signal to the actuators. For example, the display signal may comprise a plurality of pixels, each of the pixels associated with a color. In such an embodiment, each pixel may be associated with the color red, green, or blue; each color may further be associated with an intensity, for example, an intensity of 1-8. In such an embodiment, determining the haptic effect may comprise assigning a haptic effect to each color. In some embodiments, the haptic effect may comprise a direction and intensity of operation, for example, in one embodiment the haptic signal may be configured to cause a rotary actuator to rotate clockwise at one-half power. In some embodiments, the intensity of operation may be associated with the intensity of the color. Once processor 110 determines a haptic effect, it transmits a haptic signal comprising the haptic effect. In some embodiments, processor 110 may assign a haptic effect to only some of the pixels in the display signal. For example, in such an embodiment, the haptic effect may be associated with only a portion of the display signal.

**[0045]** In some embodiments, processor 110 may utilize a haptic map to determine the haptic effect and then output the display signal to display 116. In other embodiments, processor 110 may determine the haptic effect using a haptic map, and then not transmit the display signal to display 116. In such an embodiment, the display 116 may stay dark, or off, while actuator 118 is outputting the haptic effect. For example, in such an embodiment, processor 110 may receive a display signal from a digital camera associated with messaging device 102. In some embodiments, in order to conserve battery power, the user may have deactivated display 116. In such an embodiment, the processor may utilize a haptic map to provide the user with a haptic effect simulating a texture on the surface of the display. This texture may be used to alert the user when the camera is in focus, or when some other event has occurred. For example, processor 110 may use facial recognition software to determine haptic effects simulating textures at locations on display 116 that would be associated with faces if display 116 were activated.

**[0046]** In some embodiments, processor 110 may determine the haptic effect based at least in part on a user interaction or trigger. In such an embodiment, processor 110 receives an interface signal from touch-sensitive interface 114, and determines the haptic effect based at least in part on the interface signal. For example, in some embodiments, processor 110 may determine the haptic effects based on the location of the user interaction detected by touch-sensitive interface 114. For example, in such an embodiment, processor 110 may determine a haptic effect that simulates the texture of a virtual object that the user is touching on the display 116. In other embodiments, processor 110 may determine the intensity of the haptic effect based at least in part on the interface signal. For example, if touch-sensitive interface 114 detects a high pressure user interaction, processor 110 may determine a high intensity haptic effect. In another embodiment, if touch-sensitive interface 114 detects a low pressure user interaction, processor 110 may determine a low intensity haptic effect. In still other embodiments, processor 110 may determine the intensity of the haptic effect based at

least in part on the speed of the user interaction. For example, in one embodiment, processor 110 may determine a low intensity haptic effect when touch-sensitive interface 114 detects low speed user interaction. In still other embodiments, processor 110 may determine no haptic effect, unless it receives an interface signal associated with user interaction from touch-sensitive interface 114.

**[0047]** Once processor 110 determines the haptic effect, it transmits a haptic signal associated with the haptic effect to actuator 118. Actuator 118 is configured to receive a haptic signal from processor 110 and generate the haptic effect. Actuator 118 may be, for example, a piezoelectric actuator, an electric motor, an electro-magnetic actuator, a voice coil, a shape memory alloy, an electro-active polymer, a solenoid, an eccentric rotating mass motor (ERM), or a linear resonant actuator (LRA). In some embodiments, actuator 118 may comprise a plurality of actuators, for example an ERM and an LRA.

**[0048]** In one embodiment of the present invention, the haptic effect generated by actuator 118 is configured to simulate a texture that the user feels on the surface of touch-sensitive interface 114 or display 116. This texture may be associated with the graphical user interface shown on display 116. For example, display 116 may show an icon comprising the shape of a rock. In such an embodiment, processor 110 may determine a haptic effect configured to simulate the texture of a rock on the surface of touch-sensitive interface 114. Then, processor 110 will transmit a haptic signal associated with the haptic effect to actuator 118, which outputs the haptic effect. For example, when actuator 118 receives the haptic signal, it may output a vibration at a frequency configured to cause the surface of the touch-sensitive interface to comprise the texture of a rock. In other embodiments, actuator 118 may be configured to output a vibration at a frequency that causes the surface of display 116 or touch-sensitive interface 114 to comprise the texture of: water, ice, leather, sand, gravel, snow, skin, fur, or some other surface. In some embodiments, the haptic effect may be output onto a different portion of messaging device 102, for example onto its housing. In some embodiments, actuator 118 may output a multitude of vibrations configured to output multiple textures at the same time. For example, actuator 118 may output a vibration configured to cause the surface of display 116 to comprise the texture of sand. In such an embodiment, actuator 118 may be configured to output additional vibrations, configured to cause the user to feel the texture of rocks in the sand.

**[0049]** Processor 110 may determine a haptic effect for many reasons. For example, in some embodiments, processor 110 may output a haptic effect that corresponds to a texture of an object shown on display 116. In such an embodiment, the display may show multiple objects, and the processor may determine a different haptic effect as the user moves his/her finger from object to object, thus simulating a different texture for each object. In some embodiments, the haptic effect may act as a confirmation that processor 110 has received a signal associated with user interaction. For example, in one embodiment, the graphical user interface may comprise a button and touch-sensitive interface 114 may detect user interaction associated with pressing the button. When touch-sensitive interface 114 transmits an interface signal associated with the user interaction to processor 110, processor 110 may determine a haptic effect to confirm receipt of the interface signal. In such an embodiment, the haptic effect may cause the user to feel a texture on the surface